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# Implementation of Median Filter for CI Based on FPGA

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***Abstract*- This paper gives the technique to remove the impulsive noise in digital images. Impulsive noise is one of the major problems in image processing. Impulse noise from digital images can be removed by using mean and median filter. This paper presents a median filtering algorithm by using 3*3 filtering matrix.The selected platform is FPGA. The description language used is VHDL in order to implement median filter. Questasim is used for simulation. Matlab is used for image generation, introduction of salt and pepper noise & also to see pixel form of both noise-less and noisy image(0 and 255).The result shows that the impulsive noise or salt and pepper noise is remove with the help of median filter.**

***Keywords*- Image Processing, Median filter, Salt and Pepper Noise, FPGA, VHDL, Questasim.**

## I. INTRODUCTION

Digital images acquired through many consumer electronics products are often corrupted by Impulse noise [10]. Images are often corrupted by impulse noise due to errors generated in noisy sensors or communication channels. It is important to eliminate noise in the images before some subsequent processing, such as edge detection, image segmentation and object recognition. For this purpose, many approaches have been proposed [6].
It is well known that noise in the images may be introduced during the process of collection, processing and transmission. Therefore, image de-noising i.e. removal of noise from an image is an important part of image processing [1]. Image processing is a technique to enhance raw images that is Edge/details preservation [7]. Image processing algorithm need to process very large amount of data. Software implementation will be time consuming. For some systems requiring real-time processing, implementation speed is often considered as a key factor, so the image processing algorithm is suitable to be implemented in hardware. Field programmable gate array (FPGA) is suitable for pipelining and parallel data processing [1].

In the analysis of speech data and image processing, many linear filters have been used to enhance the data by smoothing the signal and by removing noise [4]. While linear filters tend to blur sharp edges, fail to remove heavy tailed distribution noise effectively, and perform poorly in the presence of signal-dependent noise [5], nonlinear filter class has been proven very useful.

As a spatial filtering technique, median filter algorithm, compared with other filtering algorithms such as the mean filter, can effectively eliminate impulse noise, salt and pepper noise and keep the image's edge information, which makes the image not to become too vague [1]. Median filters are easy to implement digitally, and they execute relatively quickly [8].

Median filter is a nonlinear filter mainly used to remove “Impulsive" noise. Impulsive" noise is also called salt-and-pepper noise. Image de-noising is a process to recover a digital image that has been contaminated by Noise. Image de-noising can be done with the help of Median filter.

Median filtering is a popular method of noise removal, employed extensively in applications Involving speech, signal and image processing [3].

## II. PROPOSED METHOD

### THE ARCHITECTURE OF MEDIAN FILTER

Our proposed method is to implement median filter in order to remove salt and pepper noise (0 and 255). Out of 256 by 256 image we use 4 by 4 image and perform operation on this image using 3 by 3 matrix. By applying median filter simultaneously on four pixel so that parallelism is achieved .Using this approach four output pixels are obtain simultaneously .The value of output pixel represent its median value. The value of each output pixel is computed using 3*3 matrix which are represented by w1, w2, w3 and w4.

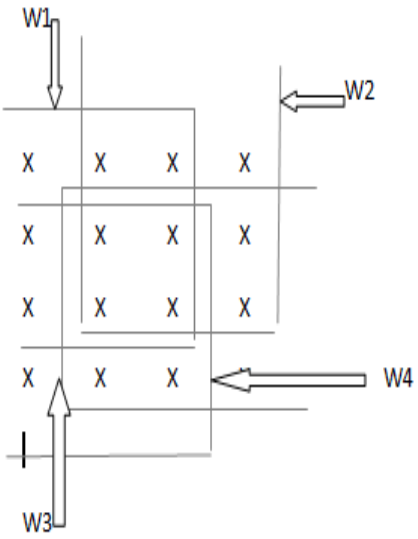


Figure 1 Computation of 4 pixels simultaneously by using 3*3 filtering

## III. BLOCK DIAGRAM

The block diagram shown below illustrates the complete process of occurrence of noise and its removal. Consider a gray scale image. Suppose due to certain reasons noise is introduce in the image. This type of image is termed as Noise image. In order to get a Noise free image median filtering is used.

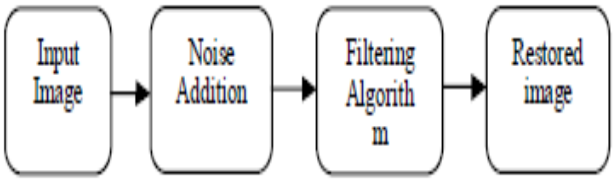


Figure 2 Block diagram for filtered image

A. STAGE –
1.) Input Image
1.1) Image Generation

B. STAGE –
2.) Noise Addition
2.1) Image with Salt & Pepper Noise
2.2) Pixel form
2.2.1) Original image
2.2.2) Noisy Image: - If 0 & 255 it Shows there is a noise
2.3) Comparing all pixels of image size

B. STAGE -
2.) Noise Addition
(256*256), if it is 0 & 255 then display "noise occurred".

C. STAGE –
3.) Filtering Algorithm
3.1) Median Filtering: median filter replace the centre pixel with a value equal to the median of all the pixels in the image
3.1.1) Consider the pixel data of 3*3 two dimensional matrix as follow –

a = imn of [imn(i-1,j-1),imn(i-1,j),imn(i-j+1),imn(i,j-1),imn(i,j),imn(i,j+1),imn(i+1,j-n(i+1,j),imn(i+1,j+1)]
Where imn (i,j)= centre pixel of noisy image

3.1.2) Centre pixel value i.e imn (i,j) will be replace by the median of all 9 pixels.
3.2) Median Filtering is perform on 4 by 4 pixel so that four output is obtained.

A. STAGE -
1.) Input Image
1.1) Image Generation


Figure (1.1) Image Generation

2.1) Image with 'salt & pepper noise'.


Figure (2.1) Image corrupted by salt and pepper noise

2.2.1) Pixel form: - Pixel Form of Original Image (Im) or Noiseless Image (Without 0 & 255)

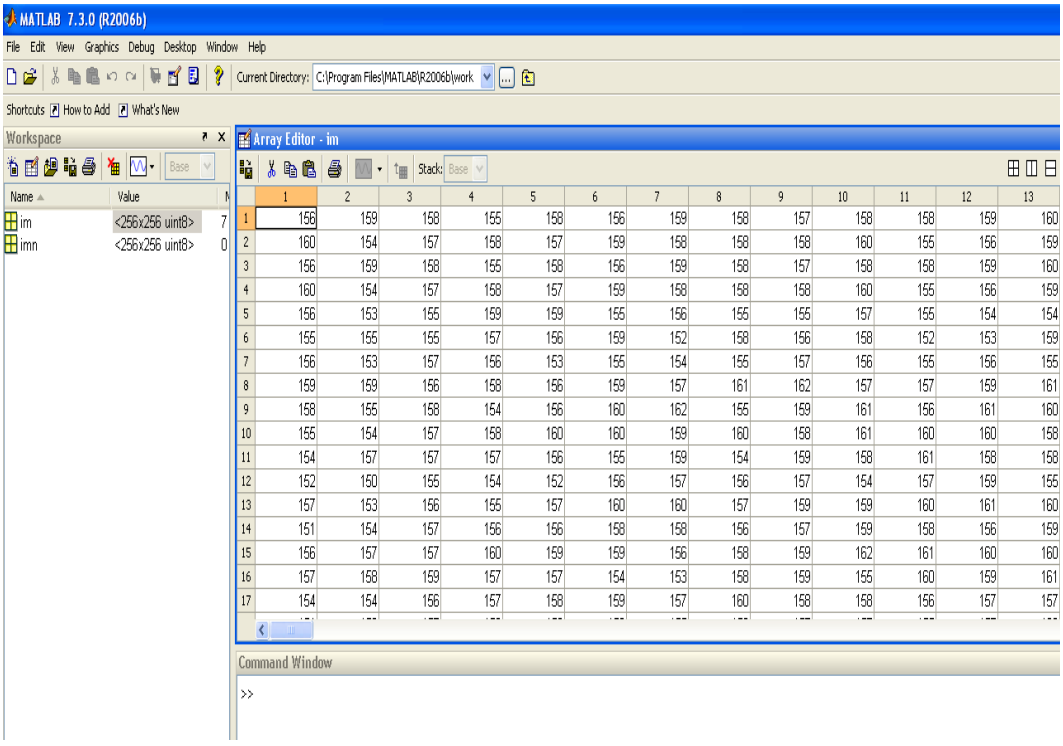


Figure (2.2.1) Pixel Form of Original Image (Im) or Noiseless Image (Without 0 & 255)

- Above fig. shows the pixel form of the original image. This is noise free image because this image does

not contain 0 and 255 in the pixel form.

- Pixel form of noisy image(imn**)** - 0 (Black)& 255(white)
- Comparing all pixels of image size (256*256), if it is 0 & 255 then display "noise occurred".

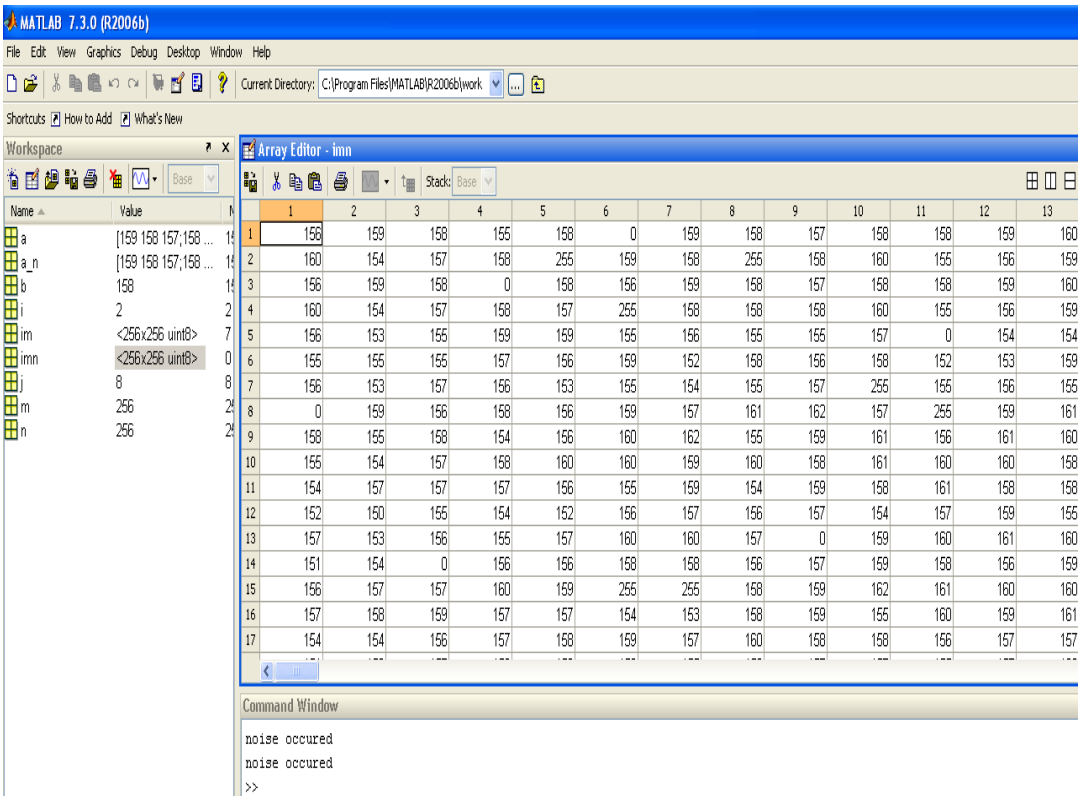


Figure (2.3) Pixel form of noisy image (imn) - 0 (Black) & 255(white)

Above fig. shows the pixel form of the Noisy image which is corrupted by salt and pepper noise .This is noisy image because this image contains 0 and 255 in the pixel form. In order to detect noise compare all pixels with 0 and 255.On detecting 0 and 255 it display 'Noise occurred' which is shown in figure (2.3).

## VI. OUTPUT

- 2 row & 5 column as shown in fig.(2.3) indicate that there is noise & display noise occurred then move to the next pixel. Now it determines noise on 2 row & 8 coloumn and again show noise occurred. In this way noise can be detect on an image. Here image size is 256*256.
- Now after noise detection next step is to remove this noise. Consider an matrix in which 2nd row & 8th column is considered as centre pixel (i,j)

C. STAGE -

3.) Filtering Algorithm

3.1) All 16 values of 4*4 matrices whose median is to be calculate is stored in a memory. As shown below-

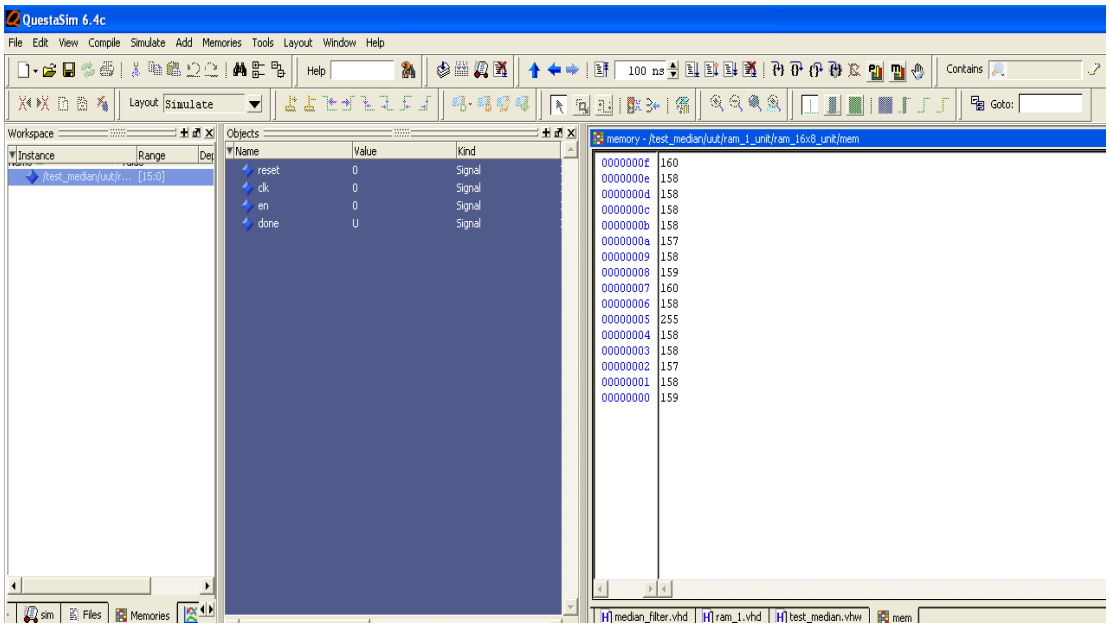


Figure (3.1) Pixel values of 4*4 matrices whose median is to be calculate

- After simulation noise ( i.e 0 and 255) should be replace by its median value.

## V. SIMULATION

- Simulation is done on Questasim.

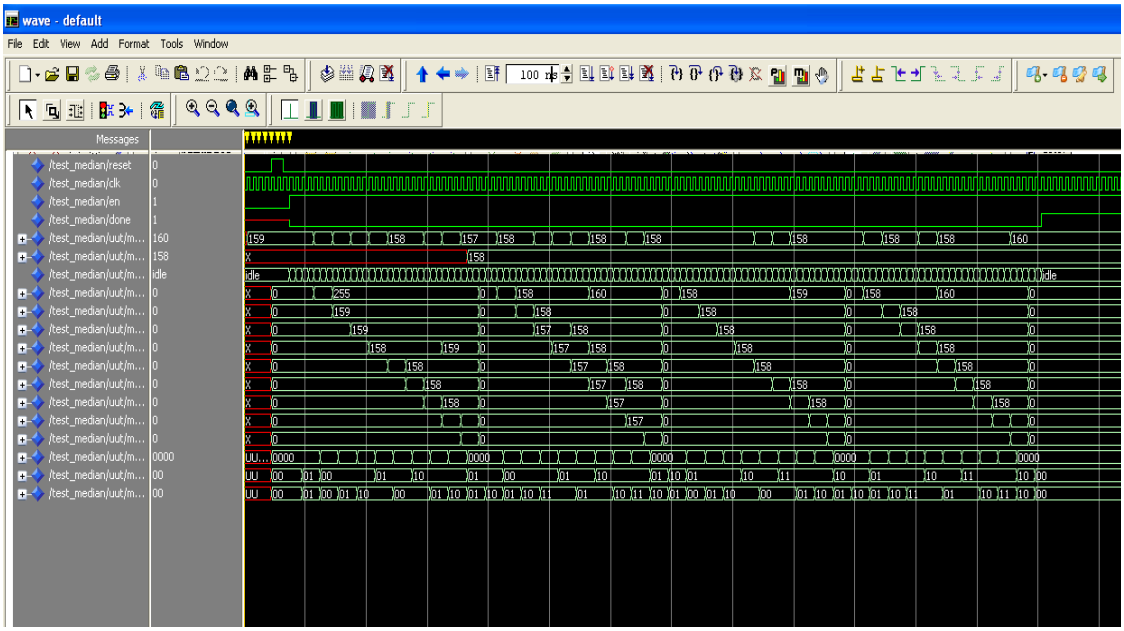


Figure (3.2) Simulation Result

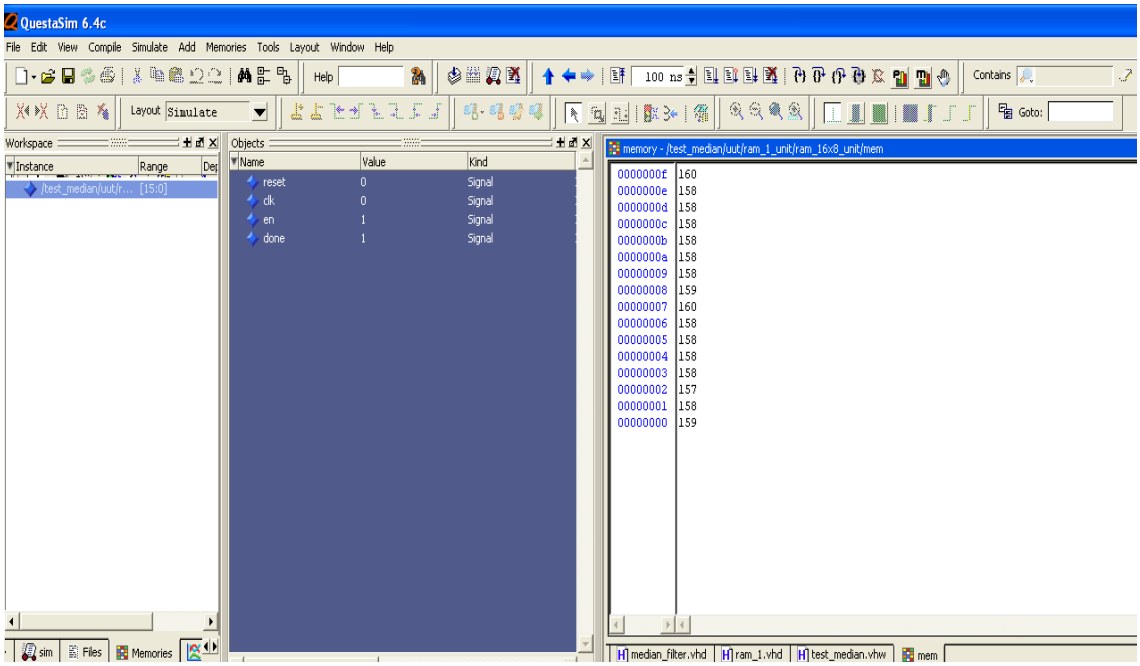


Figure (3.3) Pixel values of 4*4 matrices after median filtering

## VI. SIMULATION RESULTS

Fig.(3.1) shows pixel form of noisy image in which pixel 255 represent noise which is at 00000005 position. Simulation is done on Questasim as shown in fig. (3.2).Now after median filtering as shown in fig. (3.3) the pixel at position 00000005 is replace by 158 i.e by median value. Fig.(3.3) shows the Value stored in a memory after median filtering. In this way 'salt and pepper' noise can be remove by using median filtering.

## VII. CONCLUSION

Median filter is implemented in order to remove salt and pepper noise ( 0 and 255).By applying median filter simultaneously on four pixel we get four output in this way parallelism is achieved .The value of output pixel represent its median value.

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